ICE-MARGIN TERRAIN AND DEPOSITS:

EAST-CENTRAL LICKING COUNTY, OHIO

THE OHIO ACADEMY OF SCIENCE

GEOLOGY SECTION FIELD TRIP

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BY:
Dr. Tod A Frolking
Dept. of Geology and Geography
Denison University
Granville, Ohio 43023

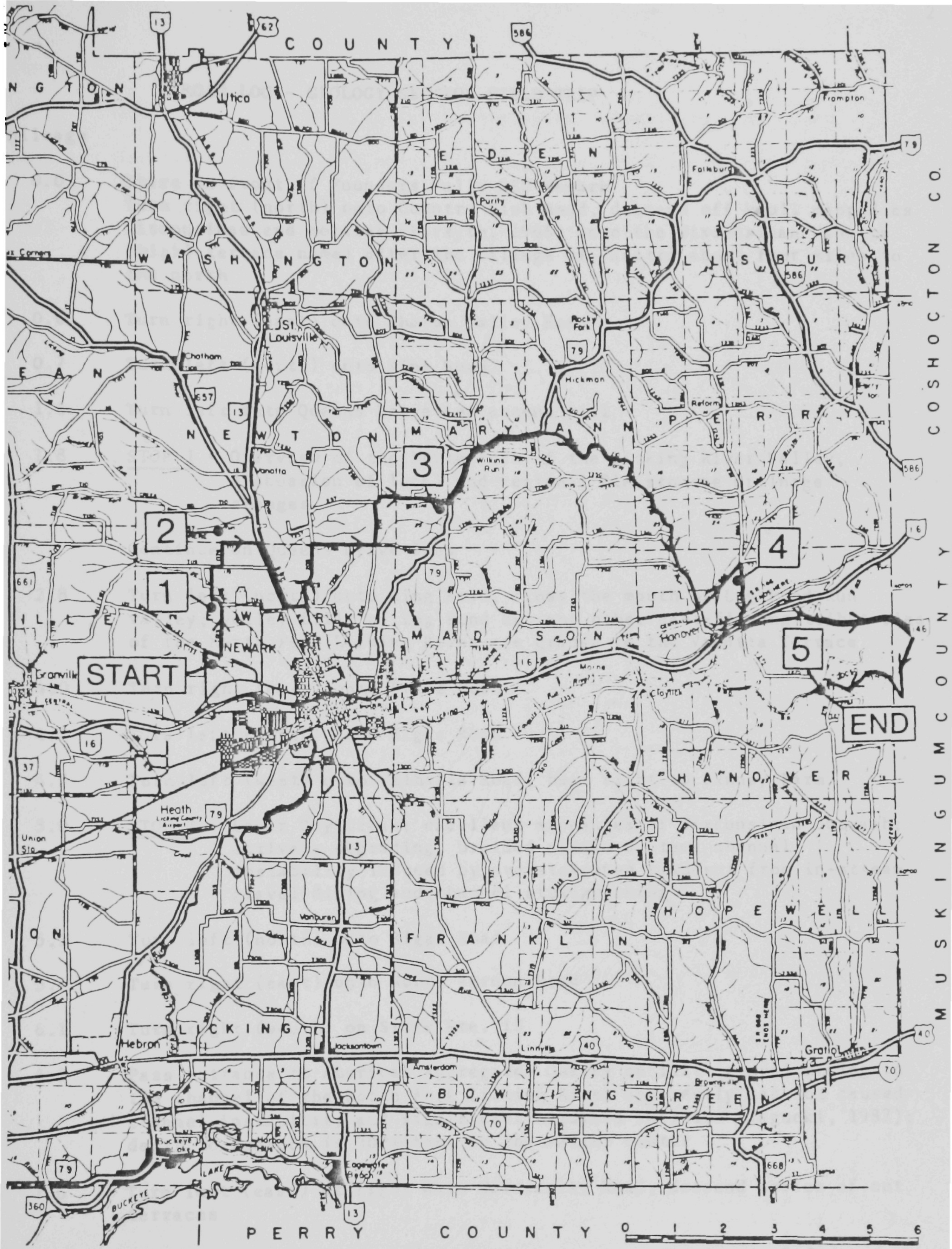

Figure 1. Map of eastern and central Licking County showing field trip route and stops

ROAD LOG - GEOLOGY SECTION FIELD TRIP

Mileage

0.0	Start in front of Founders Hall, OSU-Newark Turn right (north) onto Country Club Road, descend off knoll mapped as Wisconsinan end moraine (Forsyth, 1966) onto the Wisconsinan Vanatta (high) terrace named after the village of Vanatta about four miles to the north
0.6	Turn right (east) onto Sharon Valley Road
0.7	Turn left (north) onto King Road
1.6	Turn left onto Queens Drive and ascend hill
1.8	STOP 1 - Overview of the North Fork of the Licking River Valley, discussion of local and regional Pleistocene drainage changes Continue on Queens Drive loop
2.8	Turn left (north) onto King Road, cross the mouth of Log Pond Run valley; valley fills of Log Pond Run and other east-flowing tributaries of the North Fork Licking River are graded to the Vanatta Terrace
4.0	Turn right (east) onto Price Road
4.2	Turn left (north) onto Riggs Road
4.7	Turn left (west) onto Walhalla Road, bear right to Finney Farm
5.0	STOP 2 - Lower Dry Creek; excellent exposures of Wisconsinan outwash; actively degrading, braided stream system; channel instability induced by oversteepened gradient from in-stream gravel mining and channel straightening
5.3	Turn left (north) onto Riggs Road
5.4	Turn right (east) onto North Vernon Road
6.1	Turn right (south) on State Rte. 13
6.2	Pass entrance to American Aggregates Quarry on left, gravel mining in the channel of the North Fork Licking River apparently has not caused channel instability and significant headward incision (Jagucki, 1987); depth to bedrock is 300+ feet in the valley center
7.6	Turn left (east) at light onto Waterworks Road, descend series of cut terraces
8.0	Newark Water Works treatment plant and pumping station on left

Mileage ROAD LOG - continued

8.1 Cross North Fork Licking River, elevation approximately 820 feet

8.2 Turn left (north) onto Horns Hill Road, Newark water storage tanks on hilltop to right

9.5 Turn right (east) onto Stewart Road, hill on immediate left is an Illinoian Kame (Forsyth, 1966), ascend dissected Illinoian moraine surface which grades into Illinoian outwash at top of climb (about 1020 feet)

10.7 Turn left (north) on Martinsburg Road (Co. Rd. 204), we are now travelling along the proximal edge of a large Illinoian outwash plain, meltwater drainage was down Lost Run (east) into Rocky Fork (south); pre-Illinoian drainage of this area was to the west into the Deep Stage Utica River (Stout, et al., 1943)

Pass Newton Chapel on left, the outwash surface in this vicinity is mantled by 1.75 meters (6 feet) of Wisconsinan loess, derived principally from the North Fork Licking River (an exposure of Wisconsinan loess over Illinoian outwash will be examined at Stop 4)

11.6 Turn right (east) at intersection, then left (north) on Martinsburg Road

11.8 Turn right (east) on Swisher Road (Twp. 257)

12.7 Drop down off the Illinoian surface onto the modern floodplain of Wilkins Run; this valley did not receive Wisconsinan outwash; note color differences between oxidized, reddish brown Illinoian outwash and grayish brown modern floodplain deposits

13.1 Turn right onto driveway of Boley home and continue back to small gravel pit

13.2 STOP 3 - Illinoian outwash gravels with prominent carbonate induration

13.3 Turn right (east) onto Swisher Road

13.4 Turn left (north) onto Fallsburg Road (State Rte. 79) and follow valley of Wilkins Run

14.6 Continue on Fallsburg Road through village of Wilkins Run, now heading east in Lost Run Valley; Lost Run did receive some Wisconsinan outwash, about four miles to the northwest a tonque of Wisconsinan ice blocked drainage to the southwest causing the breaching of two divides as flow was diverted into Lost Run

16.1 Turn right onto Jores Road (gravel), the saddle through which State Rte. 79 passes is cut into a narrow remnant of the Illinoian outwash terrace which lies between Lost Run Valley and Rocky Fork Valley to the north, gravels are finer textured than those at the Boley gravel pit

Mileage ROAD LOG - continued

16.8	Note large blocks of Black Hand SS float on hillslope to the left
17.7	Cross over Rocky Fork, turn right (south) onto Hickman Road (Co. Rd. 210)
18.0	Pre-Illinoian divide, note hourglass shape of valley bottom
18.7	Note bedrock outcrop to the left - Black Hand SS of the Cuyahoga Formation at base, overlain in ascending order by the Berne, Byer, Allensville and Vinton Members of the Logan Formation
20.9	As we enter the village of Hanover, note the distinct terrace levels
21.3	Road bears left and climbs from the low Wisconsinan terrace onto the high Wisconsinan terrace and then drops back onto the low terrace
22.1	At light, turn left (northeast) on Licking Valley Road (Co. Rd. 668)
22.7	Ascend onto broad Illinoian outwash surface, elevation 910 feet
23.5	At junction, make an acute right (south) onto Seven Hills Road (Twp. 232)
23.9	Pull off road as far as possible and park in swale area
	STOP 4 - Exposure of Alford soil, Wisconsinan loess overlying a mixed silty zone over Illinoian outwash; involutions in the mixed silty zone and basal Wisconsinan loess suggest cryoturbation during late-Wisconsinan time
	Continue south on Seven Hills Road
24.6	The Bowerston Shale Co. (brickyard) on right
24.7	Intersection with State Rte. 16 access road, straight ahead over new State Rte. 16; Bowerston Shale Co. Quarry straight ahead, shale and siltsone were quarried from the Allensville and Vinton Members of the Logan Formation
24.8	Left (east) on Rock Haven Road (Twp. 275)
25.6	Climb back onto Illinoian outwash surface
26.0	Left (north) Toboso Road (Co. Rd. 273) in Boston, the Toboso bridge is closed for repair so we are detouring around to the next bridge to the east
26.1	Right (east) on Nashport Road (State Rte. 146), 898 feet elevation
28.1	Enter Muskingum County
28.4	Right (south) on Pleasant Valley Road (Muskingum Co. Rd. 408)

Mileage ROAD LOG - continued

28.8 Vinton Member of the Logan Formation crops out on right

29.1 Cross Licking River, elevation approximately 740 feet (normal pool elevation of Dillon Reservoir, which begins about 2.5 miles downstream, is 734 feet); with clean up of the Licking River, fish and waterfowl populations are increasing in this area

29.7 Right (west) on Claypool Road

30.6 Pass bedrock hill on right and out onto broad Vanatta Terrace (high Wisconsinan); the terrace elevation here is 806 feet, drill logs reveal about 15 feet of sand and gravel over a thick blue clay (lacustrine deposit?) which overlies the Black Hand sandstone at depths of 50 to 80 feet (Jones, 1959)

31.2 Toboso School on high terrace, bear right down onto Utica Terrace (low Wisconsinan)

31.3 Enter Black Hand Gorge State Nature Preserve and park vehicles.

LUNCH!

STOP 5 - Walking tour of a portion of the lower Black Hand Gorge area

END OF ROAD LOG

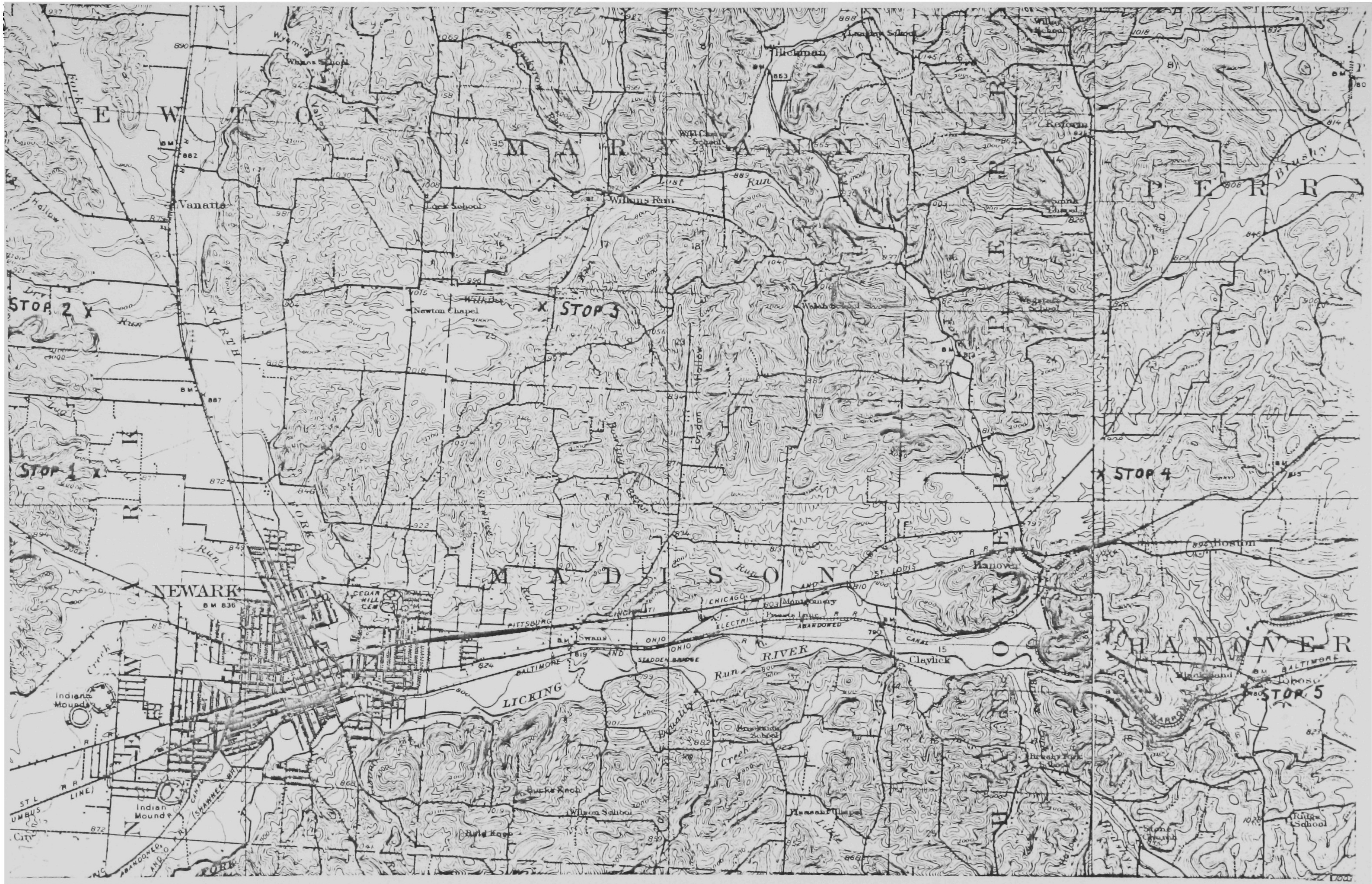

Figure 2. Topographic map of field trip area showing stops and locations of drainage reversals.

STOP 1 - OVERVIEW OF NORTH FORK LICKING RIVER VALLEY

The present regional topography and drainage patterns reflect significant glacially induced drainage diversions during the Pleistocene. Four principal stages in the drainage evolution of the region have been identified by Stout, et al. (1943). Prior to the Pleistocene, the Teays River system drained much of the state of Ohio. Eastern Licking County was drained by the westward flowing Cambridge River which was joined in Newark by a south flowing river from Utica which occupied the valley of the North Fork Licking River (Stout et al., 1943; Figure 3).

The Deep Stage followed a mid-Pleistocene ice advance which diverted many elements of the Teays drainage system, although in Licking county the drainage changes were minor. The breaching of a divide near Utica diverted drainage from Knox County southward down the Utica River (Stout et al., 1943). Cutting of a col near Granville expanded the drainage of the Raccoon Creek equivalent into the west central part of the county. The Deep Stage Newark River followed the drainage of the Cambridge River of Teays time, flowing southwest from Dresden to Hanover and then westward to Newark. The elevation of the confluence of the Newark and Utica Rivers in Newark was approximately 540 feet above present sea level (Jones, 1959). Thus, during the Deep Stage, local relief was approximately 500 feet in the vicinity of Newark.

At its maximum, Illinoian ice extended eastward to a line which approximately follows the eastern valley walls of the modern Lost Run and Rocky Fork valleys and extends due south from Hanover, approximately along the divide between Little Claylick Creek and Brushy Fork (Forsyth, 1966). Many drainage reversals and valley abandonments resulted from Illinoian ice blocking the general northeast to southwest drainage in the region. Two significant drainage modifications will be observed on this field trip (Figure 2).

1) The present Licking River was established when water, ponded by Illinoian ice east of Newark and by thick outwash deposits in the former Newark River valley in the vicinity of Hanover (Stop 4), breached a col southeast of Hanover and incised through the Black Hand sandstone creating the Licking Narrows or Black Hand Gorge (Stop 5).

2) In the region northeast of Newark, southwestward drainage, which entered the North Fork Licking River valley across the valley from our present position, was blocked and a col was breached in eastern Mary Ann Township. Drainage was diverted southward down Rocky Fork valley to Hanover.

Wisconsinan ice, which advanced eastward to the east wall of the North Fork Licking River valley, blocked much of the former westward drainage into the North Fork Licking River (Forsyth, 1966). Most flow was diverted down the Rocky Fork system. To the west of the North Fork valley, Dry Creek, which formerly drained to the southwest, was blocked by ice covering the western third of Licking County and drainage was diverted eastward into the North Fork Licking River (Stop 2).

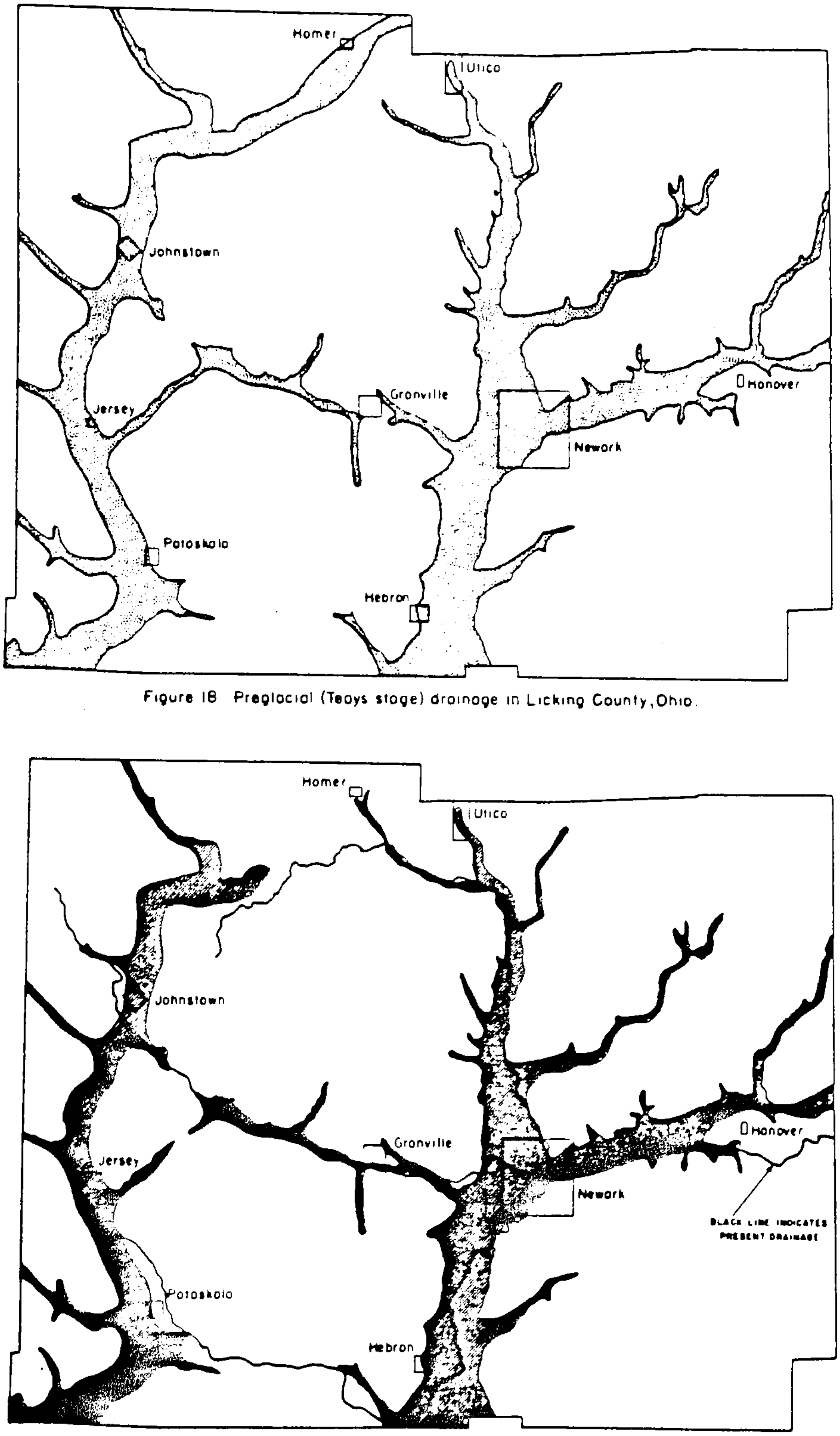

Figure 3. Maps showing A) preglacial (Teays stage) drainage and B) pre-Illinoian (Deep stage) drainage in Licking County, Ohio (from Dove, 1960).

STOP 1 - continued

The two prominent Wisconsinan outwash constructional terraces in the region are the Vanatta (high) Terrace and the Utica (low) Terrace. The Vanatta Terrace reflects the major period of outwash deposition when the ice margin was along the Johnstown Moraine (Jones, 1959). The Johnstown Moraine trends generally north-south through the west central portion of Licking County (Forsyth, 1966). Jones (1959) correlates the Utica outwash to an ice margin two miles northwest of Utica. This position necessitates a readvance of ice over the Johnstown Moraine to the northwest of Utica. Relative soil development on the two terraces suggests a short time interval between the deposition of the two units. The Vanatta Terrace is typically mantled by a significantly thicker loess deposit than the Utica Terrace indicating that loess deposition was quite active when the ice front lay at the Johnstown Moraine (Jones 1959).

STOP 2 - FINNEY FARM, LOWER DRY CREEK

Because of recent channel incision and instability, this site affords excellent exposures of Wisconsinan outwash. Note the significant component of exotic clasts including Precambrian tillite, anorthosite, diabase, quartzite, and granitic gneiss from the North Bay - Sudbury - Sault Saint Marie region of Ontario. A major focus of our stop here will be to examine changes in stream morphology induced by channel straightening and in-stream gravel mining downstream (Figure 4). We do not have time to visit an undisturbed reach of Dry Creek upstream. But it is clear that lower Dry Creek has been transformed from a meandering stream transporting a modest bedload to a braided system capable of transporting the coarsest components of the glacial outwash valley fill. In some respects, lower Dry Creek may be analogous to the braided meltwater streams that originally deposited the outwash.

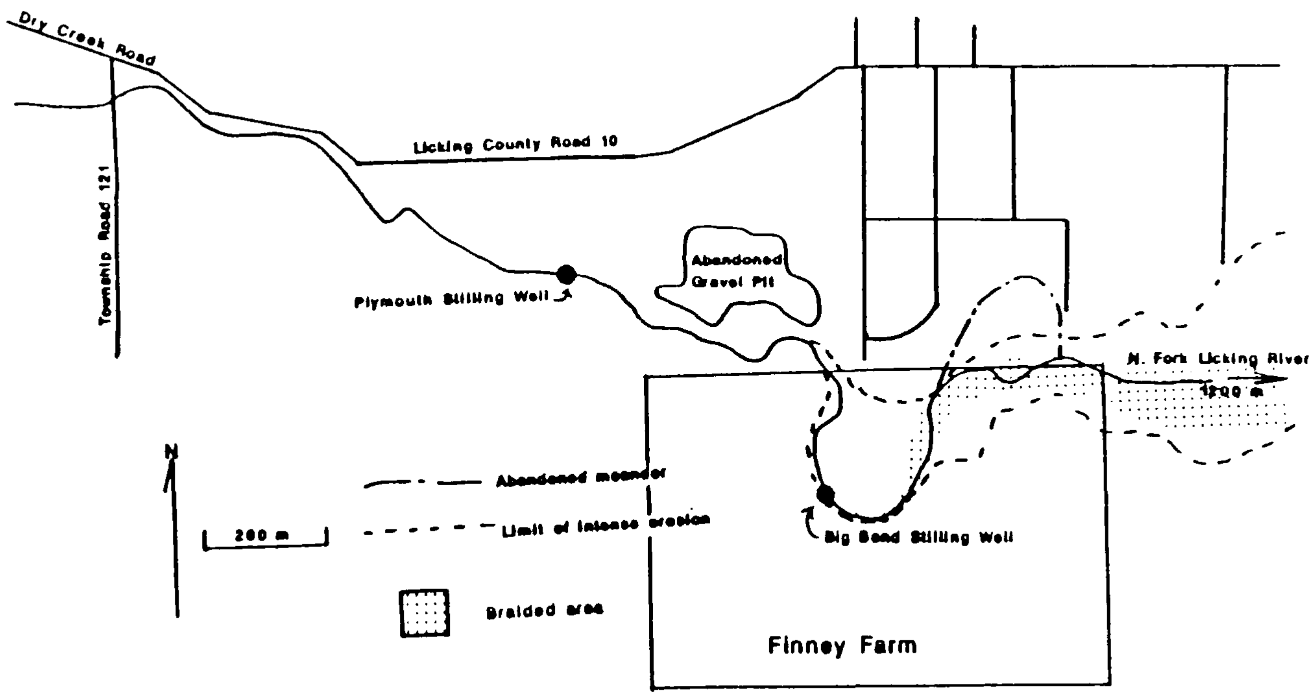

Figure 4. Diagram of lower Dry Creek showing the modern channel, cut-off meander, braided reach and the Finney farm (from Jagucki, 1987)

STOP 2 - continued

Historical records and air photos indicate that rapid channel changes were initiated soon after in-stream gravel mining began in the 1940's. The removal of gravel from the channel effectively lowered the local base level of the stream. A steepened channel section was created which then migrated upstream as channel gravels were mobilized. The rate of lateral channel migration increased as the stream adjusted to the steepened channel gradient. Two meanders, that were endangering some residences and power lines, were artifically cut-off and the channel straightened in the 1960's (Figure 4). This action, of course, steepened the channel gradient still further which in turn increased the rate of incision and channel migration upstream on the Finney property.

Several reaches of lower Dry Creek were surveyed by Burgess and Niple Ltd. (1986) and Jagucki (1987). The channel slope in undisturbed reaches upstream is about 0.0043. Average channel slope in the Big Bend meander is about 0.050 and steep reaches in the braided section have gradients up to 0.090. Thus the disturbed section of Dry Creek has seen a 10 to 20 fold increase in channel gradient. Since critical shear stress or tractive force is directly proportional to the energy slope of the stream reach, sediment transport rates have increased significantly.

Burgess and Niple Ltd. (1986) estimated that Dry Creek has eroded 11,000 cubic meters of sand and gravel per year from the Finney farm (equivalent to 600,000 metric tons of material between 1962 and 1986). Over five acres of prime farm land were lost as the Big Bend meander expanded. The average rate of cutbank erosion at Big Bend has been 1.3 meters (4 feet) per year. Prior to channel disturbance the maximum bank height was about eight feet and animals and equipment could cross the channel. Finney (1892) estimates that the bed of Dry Creek is now at least 10 feet lower than in the 1940's. Note the stairstepped form of the pointbar, with progressively younger vegetation, on the inside of Big Bend meander. Also note that the meander which was artificially cut off in the 1960's now lies well above the active channel.

In 1982, the owners of the Finney farm filed suit against the Dry Creek Crushed Gravel Company seeking payment for damages and a restriction of in-stream mining along the creek. Following a 3 1/2 year legal battle, a verdict in favor of Dry Creek Gravel was rendered by the Licking County Common Pleas Court. Dry Creek Crushed Gravel had complied with state regulations and it was not satisfactorily proven that the cause of the accelerated bank erosion was the in-stream mining rather than the channel straightening. Nevertheless, it is clear that much of the gravel sold by Dry Creek Crushed Gravel came from the Finney Farm. State Representative Marc Guthrie has since introduced House Bill 959 which seeks to restrict in-stream and near-stream mining in Ohio.

STOP 3 - BOLEY GRAVEL PIT IN ILLINOIAN OUTWASH

Be careful at this stop. As you can see there are numerous overhangs. Perhaps the most interesting feature at this gravel pit is the extreme carbonate induration of the outwash. These are pedogenic carbonates that were leached from the overlying sands and gravels. The indurated zone lies at least 20 feet below the Illinoian surface. Note that the modern drainageway in the eastern portion of the pit truncates the indurated zone, indicating that the carbonates are a relict feature predating the development of the modern drainage. Note the higher degree of weathering and ferrugination of these gravels relative to the Wisconsinan gravels exposed at Dry Creek.

STOP 4 - ALFORD SOIL, WISCONSINAN LOESS OVER MIXED ZONE OVER ILLINOIAN OUTWASH

This site was selected because of the exposure of probable cryoturbation features developed in the upper Illinoian and lower Wisconsinan silty materials. Similar involution features were observed about 2.3 km to the east southeast in exposures produced by the eastward extension of Ohio Route 16 (Everett et al., 1971). Khangarot (1969) made a detailed mineralochemical profile analysis of an Alford soil on the Illinoian outwash plain 600 m west of the Boley gravel pit (Stop 3). Involutions were not present at that site. Khangarot called the mixed silty zone, which underlies the Wisconsinan loess and overlies the Illinoian outwash, the 'intercalated zone' because of interbedding of 1" thick horizontal zones of E and C horizon material. Some physical and chemical data from Khangarot (1969) are presented below.

Soil Type: Alford silt loam (terrace taxajunct)
Classification: Ultic Hapludalf, fine silty, mixed, mesic
Location: NW 1/4, NE 1/4, Sec. 25, T3N, R11W, Mary Ann Township

Horizon	Depth (cm)	% Sand	% Silt	% Clay	pH 1:1	Base Sat.	Fe (msi)*
Ap	0-20	4.2	82.1	13.7	6.9	77	1.46
Bt21	30-43	1.9	69.6	28.5	5.9	66	1.87
Bt22	58-74	2.6	73.2	24.2	5.3	60	2.24
Bt3	89-107	3.2	76.2	20.6	5.3	48	2.22
C2	130-147	3.1	79.4	17.5	5.5	61	2.41
2E21	195-206	8.8	78.5	12.7	5.8	60	1.32
3Bt22	272-297	27.3	42.2	30.5	5.9	67	2.47
3Bt24	328-353	42.0	34.3	23.7	6.1	62	4.32

* Total iron in medium silt (5-20 um) fraction

STOP 5 - BLACK HAND GORGE STATE NATURE PRESERVE

This is the type locality of the Black Hand sandstone. The name "Black Hand" comes from an Indian petroglyph, in the shape of a hand, carved into a prominent outcrop along the Licking River in this area. The carved image eventually filled with dark-colored lichen and became darker than the surrounding sandstone. Although the rock face supporting the "Black Hand" was blasted away by canal builders about 1830, the gorge and the rock unit retain the name.

Among the geologic features to observe are cross beds of the Black Hand sandstone, honeycomb weathering, contacts of the Berne/Black Hand and Byer/Berne, and, of course, the gorge itself. A topographic map of the area showing some important features is reproduced in Figure 5. A stratigraphic column for rock units encountered on the fieldtrip is presented in Figure 6. Total thickness of the Black Hand sandstone exposed in the gorge area is about 20 meters, but wells drilled in the area pass through five times that thickness of sandstone before reaching the underlying shale. The area is interpreted as being near the core of a large progradational lobe which extended to the northwest during the sedimentation of the Cuyahoga Formation. Sedimentary structures revealed in the eastern end of the gorge provide insights into paleoenvironments of deposition. Most of the above discussion was drawn directly from Bork and Malcuit (1985).

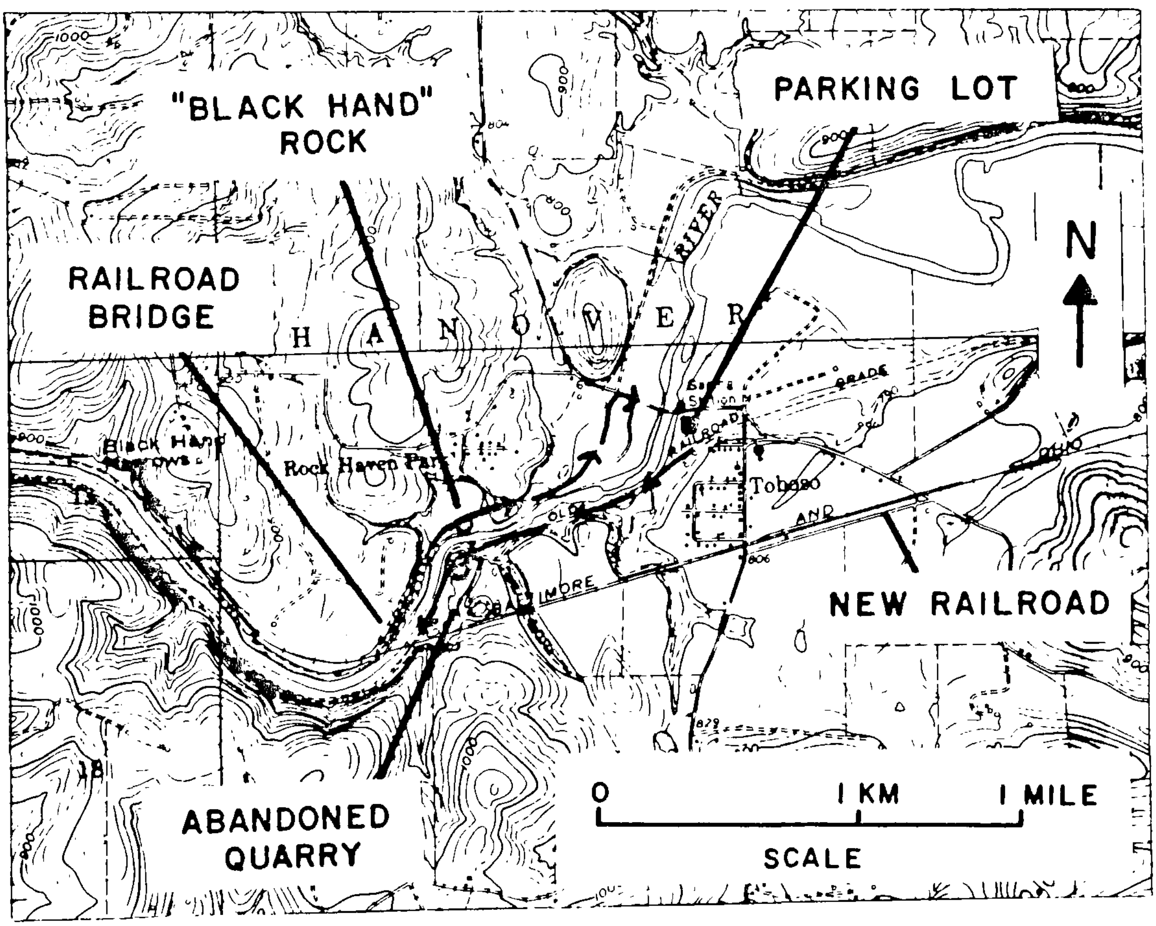

Figure 5. Topographic map of the eastern part of Black Hand Gorge showing some natural and cultural features (from Bork and Malcuit, 1985).

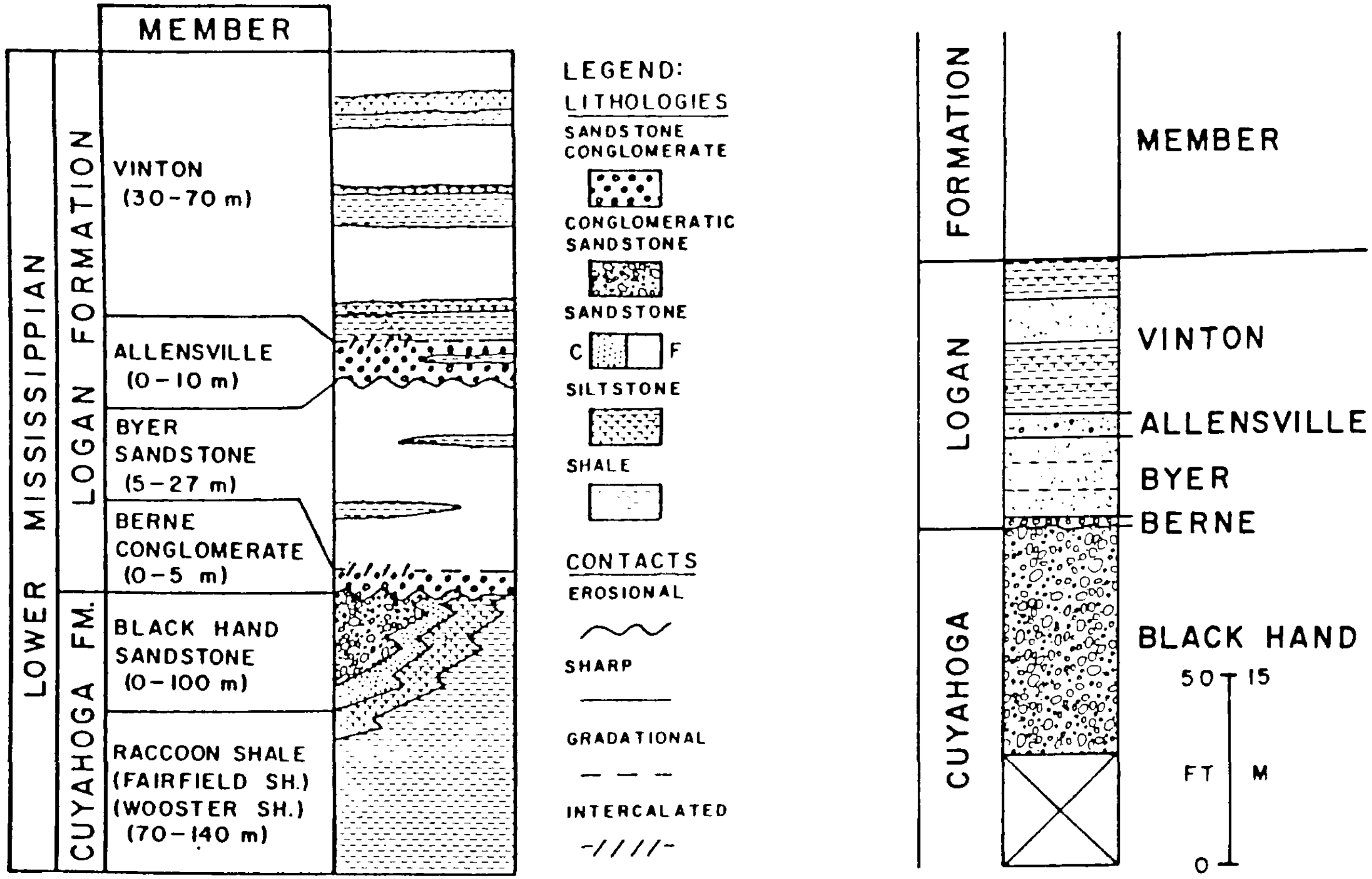

Figure 6. Stratigraphic columns of A) the Cuyahoga and Logan Formations of east-central Ohio and B) the Black Hand Gorge area showing thicknesses of units (from Bork and Malcuit, 1985).

STOP 5 - continued

A model for the Pleistocene evolution of Black Hand Gorge is depicted in Figure 7. Stratigraphic relationships indicate that the gorge was cut by Illinoian meltwater (Jones, 1959). Jones suggests that the rate of lowering of the cut may have been controlled by the level of the lake to the east which was formed by the damming of the Newark River by Illinoian deposits. The gorge must have been cut before the ice front had receded west of Newark, because a drainage route would then have been opened to the south.

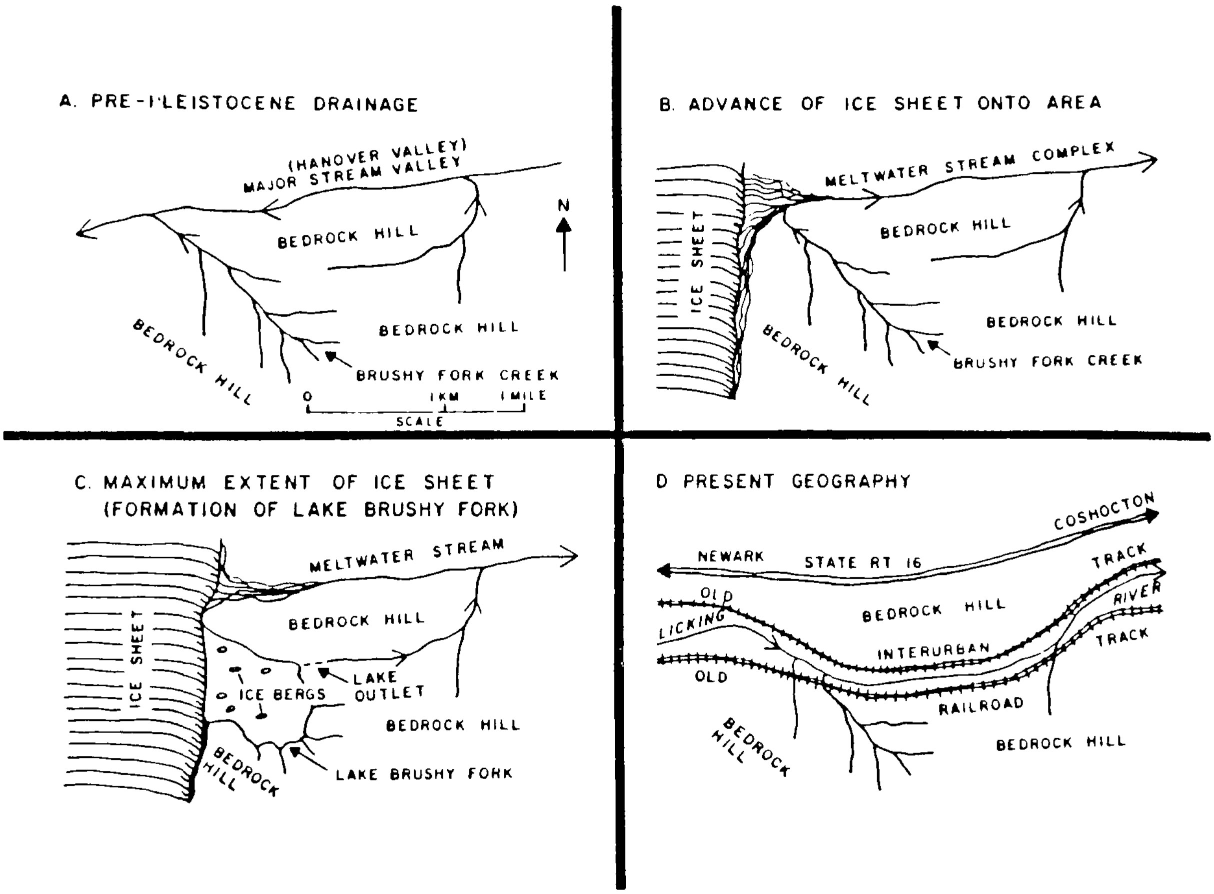

Figure 7. Diagrammatic sketches showing three stages in a model for the evolution of Black Hand Gorge, as well as the present geography of the gorge area (from Malcuit and Bork, 1987).

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